Nematology Circular No. 166
June 1989

Fla. Dept. Agric. & Consumer Serv.
Division of Plant Industry

THE RICE ROOT-KNOT NEMATODE MELOIDOGYNE GRAMINICOLA GOLDEN & BIRCHFIELD 1965.

J. B. MacGowan[1]

INTRODUCTION: During the latter part of 1963, a high population of unidentified root-knot nematodes was found infecting the roots of Echinochloa colonum (L.) Link (a barnyard grass) growing in the cotton and sweet potato plots on the Louisiana State University Farm at Baton Rouge (4,7). Subsequent greenhouse and laboratory tests by Birchfield in 1964 and 1965 (3,4) demonstrated that this nematode readily infected several grasses including oats. It did not appear to infect crops of corn, pepper, cotton, sweet potatoes, and watermelon (3,4,7). This nematode was described as a new species of root-knot nematode, Meloidogyne graminicola Golden and Birchfield 1965 (8). In 1967, Golden confirmed the identification of nematodes suspected of being M. graminicola infecting rice from Laos and India (8). Subsequent greenhouse tests at Baton Rouge confirmed that rice grown in the USA was susceptible to this nematode. Although the economic impact of M. graminicola on rice had yet to be studied, the common name "rice root-knot nematode" was proposed for this species by Golden and Birchfield in 1968 (8).

HISTORICAL BACKGROUND: Internationally, the rice root-knot nematode is known to be established in India, Laos, Bangladesh, Thailand, United States, and Vietnam (5,6,22,23). In the United States, surveys reported by Hollis indicate that small populations can be found in 20-30% of the rice paddies in Texas and Louisiana (9). In 1984, M. graminicola was discovered on Cyperus rotundus L. (purple nutsedge) at the Southeast Georgia Experiment Station in Midville, Georgia (11). At the time of this writing, it is not known to occur in Florida.

Root-knot nematodes have been known to parasitize rice since 1932, when Tullis described dwarfed and chlorotic plants, lacking vigor, which appeared in a 1 1/2 acre spot in a rice field near Stuttgart, Arkansas (21). Subsequent investigations revealed roots which were deformed and parasitized by the root-knot nematode known at that time as Heterodera marioni (Cornu) Goodey. In 1979, Yik and Birchfield stated they believed the causal organism in Tullis's account was actually Meloidogyne graminicola rather than Heterodera marioni (23).

Rice is believed to have first been domesticated in India, although the oldest surviving written record telling of its existence 5000 years ago is from China (1). It is the staple food for about half the population of our planet, and 80% or more of the world rice production is reported to be cultivated in the highly populated southern and eastern parts of Asia (2,10). Half of the world rice crop is consumed on the farms where it is grown and only 5% enters international trade (15).

---

[1]Nematologist, Bureau of Nematology, P.O. Box 1269, Gainesville, FL 32602

The first commercial production of rice in the United States began in 1685 in South Carolina (1). As late as 1985-86, it was estimated that the U.S. produced 6,097,000 metric tons of rice. Although this represents only 1.3% of the world production, the U.S. was the world's second largest exporter of rice. This represents 20% of the rice traded on the world market. The rice producing states in the U.S. are Arkansas, Louisiana, California, Texas, Mississippi, and Florida (10).

As early as 1763, rice was grown in Florida. According to one early account, "many barrels of rice" were apparently shipped out of St. Marks for Europe (2). In 1917, commercial production had reached 803 acres. In the period from 1919 to 1924 the average acreage was 3002. Production declined until the 1950s when the rice growing areas of the Everglades experienced a renewal of commercial interest, and production eventually approached 2000 acres. In 1957, the federal government halted the production of rice in the Everglades area due to the appearance of the virus disease hoja blanca (white leaf), and the government's fear that it might spread to other rice producing areas of the United States (3). The controls against growing rice were lifted in 1974 and growers continued planting rice as a cover crop. In 1977, after twenty years, growers again began producing rice for grain (1). Today, it is estimated that 13,500 acres of rice are under production in the Everglades area of Florida.

ECONOMIC IMPACT: The rice root-knot nematode has been reported as a pest of upland rice, rice crops which have been drained, deep water rice, and rice nurseries (14). In India, it has been reported to cause yield losses of 17-30% due to poorly filled kernels in upland rice (14,18). Pot experiments (2000 nematodes per plant) with varieties of deep water rice in Bangladesh showed severe stunting of root and shoot development with a 60% reduction in yield, while field populations of 1000 nematodes per kg soil caused "poor plant growth and yields" (16). In Vietnam, 30 days after sowing, galls on the roots of the rice plants averaged 13-15 per plant, height was decreased by 31-48%, and yields were reduced by 65% (6).

LIFE CYCLE: In flooded rice varieties (paddy and deep water), young rice seedlings growing in drained soil prior to flooding are the most susceptible and most readily infected stage of the rice plant. Controlled studies have shown that infective juveniles penetrated roots within 5 hours after inoculation, and many larvae often entered a root through the same opening (17). Root growth became impaired and both hypertrophy and hyperplasia were observed after 72 hours (12). Once a field was flooded, the nematodes completed their development, matured, laid eggs, and produced a second generation inside the roots of the same plant which was originally infected as a seedling. Roots depleted of nutrients were abandoned by nematode juveniles which usually did not reinvade other flooded roots. They disperse in the floodwater of the paddy which appears to be their chief means of dissemination, and survive in the soil until the field is drained and new seedlings are planted. In India, pot experiments by Roy (20) indicate that eggs will remain viable in moist and waterlogged soils for as long as 12 months (19). In Bangladesh, M. graminicola could not be found in infected roots after they had been flooded for as long as 5 months (5). The life cycle of the rice root-knot nematode is completed in 26-51 days depending upon the time of the year (12).

SYMPTOMS: In pot experiments of rice infected with M. graminicola, it was observed that the entire plant was affected. On the aboveground parts of the plant, tip drying was observed at all levels of inoculum which employed from 1 to 16 egg masses per plant. It was reported that plants were chlorotic and that leaf bronzing developed from the tip downward and from the margins inward toward the midrib of the blade. Emerging leaves were crinkled and tiller height was reduced. Severely infected plants flowered and matured early. Emerging panicles were crinkled, grain setting was poor, and chaffiness was observed in the panicles (13). Belowground, knots appeared in a string on the roots, and an abnormal development of small slender lateral roots produced a "hairy root system." Although individual galls were beaded, clubbed, or spindle shaped, when the infection was heavy, they coalesced. In an earlier study, galls developed in a "characteristic ring form" with hair-like lateral growths on the convex side of the gall curvature (19). The root system was described as a profuse proliferation of roots which were very slender and fluffy. Small galls appeared 4 days after inoculation, and grew to 13 mm long and 2.29 mm wide following egg production (13).

Meloidogyne graminicola is also known to damage deep water rice in Bangladesh. Deep water or "floating rice" varieties grow extremely fast in order to keep pace with rapidly rising floodwaters which may eventually be as much as 1 to 5 meters deep. A series of experiments was designed to simulate the deep water rice conditions of Bangladesh (5). This nematode stunted the growth of young plants, thereby reducing their ability to elongate fast enough to keep pace with rising floodwater. The flooded roots had more large galls than roots of plants grown in drained soil. The young plants became detached from their anchor roots and floated to the surface (5).

SURVEY AND DETECTION: Rice fields should be inspected for unthrifty plants which may show bronzing, yellowing, reduced yield, sparse growth or root galls. A pint of roots, and soil if possible, should be sent to a nematology laboratory with a description of symptoms and a clear statement specifying that the sample be checked for Meloidogyne graminicola.

LITERATURE CITED:

1. Alvarez, Jose. 1978. Potential for commercial rice production in the everglades. Economic Information Report 98. Food & Resources Economics Dept., Agric. Expt. Stations, IFAS, Univ. Fla., Gainesville, FL. 37 pp.
2. _____. 1979. Florida establishing rice industry. The Rice Jour. 82(3):22-26.
3. Birchfield, W. 1964. Histopathology of nematode-induced galls of Echinochloa colonum. (Abstr.). Phytopathology 54:888.
4. _____. 1965. Host-parasite relations and host range studies of a new Meloidogyne species in southern U.S.A. Phytopathology 55(12):1359-1361.
5. Bridge, J., and S. L. J. Page. 1982. The rice root-knot nematode, Meloidogyne graminicola, on deep water rice (Oryza sativa subsp. indica). Rev. de Nematologie 5(2):225-232.
6. Dang-Ngoc Kinh, N. M. Huong, and N. V. Ut. 1982. Root-knot disease of rice in the Mekong Delta, Vietnam. International Rice Research Newsletter 7(14):15.

7. Golden, A. M., and W. Birchfield,. 1965. Meloidogyne graminicola (Heteroderidae) a new species of root-knot nematode from grass. Proc. Helminth. Soc. Wash. 32(2):228-231.
8. _____, and _____. 1968. Rice root-knot nematode (Meloidogyne graminicola) as a new pest of rice. Plant Dis. Reptr. 52(6):423.
9. Hollis, J. P., Jr. 1988. Nematode parasites of rice. In R. W. Nickel, ed. Plant and insect nematodes. Marcel Dekker, New York, pp. 95-146.
10. Jones, D. B., G. H. Snyder, and J. Alvarez. 1987. Rice and other aquatic crops. P. 16. In F. T. Izuno and D. B. Bottcher (ed.). The effects of on-farm agricultural practices in the organic soils of the EEA on phosphorus and nitrogen transport. Part 2. Phase II final report to South Florida Water Management District.
11. Minton, N. A., E. T. Tucker, and A. M. Golden. 1987. First report of Meloidogyne graminicola in Georgia. Plant Dis. Reptr. 71(4):376.
12. Mulk, M. M. 1976. Meloidogyne graminicola. C.I.H. Descriptions of plant parasitic nematodes. Commonwealth Inst. Helminth. (1976) Set 6, No. 87, 4 pp.
13. Patnaik, N. C., and N. N. Padhi. 1987. Damage by rice root-knot nematode. International Rice Research Newsletter 12(4):27.
14. Prasad, J. S., M. S. Panwar, and Y. S. Rao. 1986. Screening of some rice cultivars against the root-knot nematode, Meloidogyne graminicola. Indian J. Nematol. 16(1):112-113.
15. Purseglove, J. W. 1972. Tropical crops, monocotyledons. Longman, New York. 607 pp.
16. Rahman, M. L., and B. Taylor. 1983. Nematode pests associated with deepwater rice in Bangladesh. International Rice Research Newsletter 8(3):21-22.
17. Rao, Y. S., and P. Israel. 1973. Life history and bionomics of Meloidogyne graminicola, the rice root-knot nematode. Indian Phytopathology 26(2):333-340.
18. Rao, Y. S., R. N. Jena, and K. S. K. Prasad. 1977. Infectivity of two isolates of Meloidogyne graminicola in rice. Indian J. Nematol. 7(1):98-99.
19. Roy, A. K. 1973. Reaction of some rice cultivars to the attack of Meloidogyne graminicola. Indian J. Nematol. 3(1):72-73.
20. _____. 1982. Survival of Meloidogyne graminicola eggs under different moisture conditions in vitro. Nematologia Mediterranea 10(2):221-222.
21. Tullis, E. C. 1934. The root-knot nematode on rice. Phytopathology 24:938-942.
22. Yik,C. P., and W. Birchfield. 1977. Additional knowledge on the biology and hosts of Meloidogyne graminicola. Division Meetings 1977. Abstract No. S-46. Proc. Amer. Phytopath. Soc. 4:231.
23. _____, and _____. 1979. Host studies and reactions of rice cultivars to Meloidogyne graminicola. Phytopathology 69(5):497-499.

Contribution No. 382, Bureau of Nematology

This publication was issued at a cost of $ 581.02 or $ 0.17 per copy to provide information on proper recognition of plant pests. PI89T-27